Citation:

Striegel-Moore RH, Thompson D, Affenito SG, Franko DL, Obarzanek E, Barton BA, Schreiber GB, Daniels SR, Schmidt M, Crawford PB. Correlates of beverage intake in adolescent girls: the National Heart, Lung, and Blood Institute Growth and Health Study.*J Pediatr.* 2006 Feb;148(2):183-7.

PubMed ID: 16492426

Study Design:

Longitudinal Study

Class:

B - Click here for explanation of classification scheme.

Research Design and Implementation Rating:

POSITIVE: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

To examine longitudinal changes in consumption of six types of beverages (milk, diet and regular soda, fruit juice, fruit-flavored drinks, and coffee/tea) in girls and determine the relationship between beverage intake and body mass index (BMI) and nutrient intake.

Inclusion Criteria:

Participated of the National Heart, Lung, and Blood Institute (NHLBI) Growth and Health Study.

Exclusion Criteria:

Excluded if they did not self identify themselves as "black" or "white", non-Hispanic, with racially concordant parents or guardians.

Description of Study Protocol:

Recruitment

- Must have participated in the NHLBI Growth and Health Study
  - The University of California at Berkeley recruited girls from public and parochial schools in the Richmond Unified School District
  - University of Cincinnati/Cincinnati Children's Hospital Medical Center recruited girls from all public and parochial schools in Hamilton County
  - Westat, Inc./Group Health Association in Rockville, Maryland, randomly selected girls from families who were enrolled in a large Washington, DC-area health maintenance organization and, because of an insufficient number of white families with age-eligible girls, recruited girls from several local Girl Scout troops in the same geographical area.

Design: Longitudinal Study

Blinding used (if applicable): not applicable

Intervention (if applicable)

- Girls participated in 10 approximately annual assessment "visits" at participating sites or, when the girl was unable to travel to the site, at her home.
- Demographic information was collected at study entry from girls and their parents (or guardians).
- BMI was calculated annually.
- Three-day food records were collected annually for visits 1 to 5 and then again at visits 7, 8, and 10.
- Beverages were coded as
  - milk (all kinds of cow's milk, including flavored varieties)
  - regular soda (all non-diet carbonated beverages, except water)
  - diet soda (all diet carbonated beverages, excluding water)
  - fruit juice (fruit and vegetable juices)
  - fruit drinks (fruit-flavored drinks, punches, ades that contain < 100% juice)
  - coffee/tea

Statistical Analysis

- Mixed models (PROC MIXED) were used to account for within-girl correlation of beverage consumption reports at different visits
- Main effects and interactions were evaluated by using likelihood ratio tests, which have a chi-square distribution
- Separate mixed models were used to estimate the relations between beverage consumption and each dependent variable.

Data Collection Summary:

Timing of Measurements

- Girls participated in 10 approximately annual assessment "visits" at participating sites or, when the girl was unable to travel to the site, at

her home.
- Demographic information was collected at study entry from girls and their parents (or guardians).
- BMI was calculated annually.
- Three-day food records were collected annually for visits 1 to 5 and then again at visits 7, 8, and 10.
- Data collection commenced in 1987 and ended in 1997

Dependent Variables

- BMI - calculated on the basis of the research staff's measures of girls' height and weight (weight in kilograms divided by height in meters squared)
- Average daily intake of total calories - assessed using 3 day food records
- Sucrose - assessed using 3 day food records
- Fructose - assessed using 3 day food records
- Total Sugars - assessed using 3 day food records
- Calcium - assessed using 3 day food records

Independent Variables

- Beverage consumption

Control Variables: none described

Description of Actual Data Sample:

Initial N: 2371 females

Attrition (final N): All 2371 (99.7% of the NGHS participants) completed a food diary at 1 or more visits

Retention was high at visits 2, 3, and 4 (96%, 94%, and 91%, respectively), declined to 82% at visit 7, and increased to 89% at visit 10.

Age: All girls were 9 or 10 years old at study entry

Ethnicity: n=1210 black and n=1161 white

Other relevant demographics: not described

Anthropometrics

Location:

- Richmond Unified School District (California)
- Hamilton County (Cincinnati)
- Rockville, Maryland and Washington, DC-area

Summary of Results:

Key Findings

- White girls' milk intake decreased steadily from ages 11.5-15.5 years
- Black girls' milk consumption decreased at a greater rate than white girls' did.
- The rate of increase in regular soda consumption was greater among black girls than among white girls until 16.5 years, when black girls soda intake leveled off but white girls' soda intake continued to increase
- White girls' intake of diet soda increased steadily throughout the entire period
- At all visits black girls consumed more fruit drinks than white girls did
- White girls' intake of coffee/tea did not increase between ages 9.5-12.5 years, but it increased steadily after 12.5 years, as did black girls, but to a lesser extent.
- Consumption of beverages was associated with an increase in average daily caloric intake [chi-squares (1) = 49.95-2072.68, P value<0.0001]
- Drinking milk, soda, fruit drinks, or coffee/tea was associated with increased average daily sucrose consumption [chi-squares (1) = 5.85-469.34, P value<0.05]
- Diet soda consumption was associated with a significant decrease in average daily sucrose intake [chi-square (1) = 6.63, P<0.01]
- Drinking soda, fruit juice, or fruit drinks was strongly associated with increased average daily fructose consumption [chi-squares (1) = 7809.30-13752.38, P value<0.0001]
- Drinking milk or coffee/tea was associated with decreased average daily fructose intake [chi-squares (1) = 22.79 and 8.25, respectively; P value<0.05]
- All beverages except diet soda were associated with increased intake of average daily total sugar intake [chi-squares (1) = 213.98-5300.18, P value<0.0001]
- Milk consumption, and, to a lesser extent, diet soda consumption were associated with increased average daily calcium intake [chi-squares (1) = 73.35 and 1000.65, respectively; P values<0.0001]
- Consumption of regular soda, fruit drinks, or coffee/tea was associated with significant decreases in average daily calcium intake [chi-squares (1) = 6.46-94.17, P values<0.05]

Mean Daily consumption (standard error) of each type of beverage (in grams), by race and visit									
		Visit (mean age in years at visit)							
Race	**Beverage**	**1 (9.5)**	**2 (10.5)**	**3 (11.5)**	**4 (12.5)**	**5 (13.5)**	**7 (15.5)**	**8 (16.5)**	**10 (18.6)**
White	Regular Soda	135.45 (8.29)	164.33 (8.54)	201.70 (8.63)	216.56 (9.32)	242.12 (9.13)	274.48 (9.74)	329.70 (9.90)	377.02 (9.09)
	Diet Soda	22.36 (4.52)	33.82 (4.66)	37.39 (4.71)	49.60 (5.09)	52.65 (4.99)	71.48 (5.32)	72.63 (5.41)	81.86 (4.96)

	Milk	352.04 (7.22)	340.00 (7.44)	348.83 (7.52)	320.07 (8.12)	306.28 (7.96)	290.20 (8.49)	262.24 (8.63)	241.99 (7.92)
	Coffee/Tea	19.78 (3.45)	20.09 (3.55)	22.74 (3.59)	22.35 (3.88)	27.90 (3.80)	53.31 (4.06)	67.44 (4.12)	105.60 (3.78)
	Fruit Juice	110.46 (4.94)	106.70 (5.09)	111.64 (5.15)	103.80 (5.56)	120.58 (5.45)	124.81 (5.81)	119.38 (5.91)	128.68 (5.42)
	Fruit Drinks	78.41 (4.39)	82.23 (4.53)	81.91 (4.57)	95.39 (4.94)	84.41 (4.84)	80.26 (5.17)	96.92 (5.25)	87.16 (4.82)
Black	Regular Soda	134.53 (7.85)	173.15 (7.87)	210.44 (7.76)	244.96 (8.33)	299.41 (8.13)	326.06 (8.79)	347.19 (8.73)	338.48 (8.11)
	Diet Soda	7.20 (1.75)	11.53 (1.75)	8.38 (1.73)	10.28 (1.86)	8.59 (1.81)	10.21 (1.96)	8.65 (1.95)	9.46 (1.81)
	Milk	244.13 (5.36)	237.99 (5.37)	214.83 (5.30)	180.44 (5.68)	160.30 (5.55)	150.45 (6.00)	147.57 (5.96)	144.62 (5.53)
	Coffee/Tea	19.50 (2.61)	18.94 (2.61)	17.55 (2.58)	18.66 (2.77)	23.03 (2.70)	29.08 (2.92)	41.11 (2.90)	46.84 (2.69)
	Fruit Juice	108.36 (4.86)	103.91 (4.87)	105.43 (4.81)	93.32 (5.16)	110.02 (5.03)	115.38 (5.44)	105.80 (5.41)	119.81 (5.02)
	Fruit Drinks	134.68 (6.78)	144.47 (6.80)	169.44 (6.71)	173.27 (7.19)	159.73 (7.02)	212.74 (7.59)	202.34 (7.54)	204.41 (7.00)

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Relationship among beverage consumption (in units of 100g/day) and outcomes of body mass index and average daily intake of total energy, sucrose, fructose, total sugars, and calcium

	Beverage parameter estimate (Standard Error)					
Outcomes	**Milk**	**Regular Soda**	**Diet Soda**	**Fruit Juice**	**Fruit Drinks**	**Coffee/Tea**
BMI	-0.002(0.006)	0.011 (0.005)[a]	-0.010 (0.013)	0.005 (0.007)	0.009 (0.007)	0.05 (0.013)
Daily Energy (kcal)	96.4 (2.2)[d]	81.5 (1.7)[d]	29.1 (4.1)[d]	81.3 (2.7)[d]	81.3 (2.3)[d]	46.3 (4.3)[d]
Daily Sucrose (g)	0.2 (0.1)[a]	0.6 (0.1)[d]	-0.5 (0.2)[b]	0.2 (0.1)	2.3 (0.1)[d]	3.8 (0.2)[d]
Daily fructose (g)	-0.15 (0.03)[d]	3.99 (0.03)[d]	-0.01 (0.06)	4.89 (0.04)[d]	3.43 (0.03)[d]	-0.18 (0.06)[b]
Daily total Sugar (g)	4.3 (0.1)[d]	7.8 (0.1)[d]	-0.3 (0.2)	9.4 (0.1)[d]	8.9 (0.1)[d]	3.4 (0.2)[d]
Daily Calcium (mg)	103.1 (0.8)[d]	-7.0 (0.7)[d]	13.7 (1.6)[d]	1.7 (1.1)	-2.3 (0.9)[a]	-6.7 (1.7)[c]

- a. P<0.05
- b. P<0.01
- c. P<0.001
- d. P<0.001 (H_0: parameter estimate = 0)

Author Conclusion:

Public health efforts are needed to promote healthful beverage choices and decreased soda consumption in adolescent girls to positively influence health outcomes.

Reviewer Comments:

Authors note the following limitations:

- *Dietary information was based on self-report and may be subject to recall errors or under-reporting*
- *Before data entry, food was reduced into main ingredients, making it impossible to relate beverage to consumption of specific foods or type of meals (e.g. fast food)*
- *It was not possible to report beverage consumption for each age*
- *NGHS is not a representative sample of girls*
- *Lactose intolerance, socioeconomic status and number of younger siblings might play a role in the types of beverages being consumed. If someone is lactose intolerant and/or has a milk allergy, there are alternatives to cow's milk but cost might be a factor in purchasing those products. In some cases, the consumption of milk vs other beverages might be an availability issue, not an issue of preference.*

Research Design and Implementation Criteria Checklist: Primary Research

Relevance Questions		
1.	Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies)	N/A
2.	Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?	Yes
3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	Yes
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	N/A

Validity Questions		
1.	**Was the research question clearly stated?**	Yes
1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes
1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes
1.3.	Were the target population and setting specified?	Yes
2.	**Was the selection of study subjects/patients free from bias?**	Yes
2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	Yes
2.2.	Were criteria applied equally to all study groups?	Yes
2.3.	Were health, demographics, and other characteristics of subjects described?	No
2.4.	Were the subjects/patients a representative sample of the relevant population?	Yes
3.	**Were study groups comparable?**	Yes
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	Yes
3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	Yes
3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	Yes
3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	Yes
3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	N/A
3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
4.	**Was method of handling withdrawals described?**	???
4.1.	Were follow-up methods described and the same for all groups?	Yes
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	Yes
4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	Yes
4.4.	Were reasons for withdrawals similar across groups?	???
4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A
5.	**Was blinding used to prevent introduction of bias?**	Yes
5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	N/A
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	Yes
5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	Yes
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A
5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
6.	**Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were interveningfactors described?**	Yes
6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	N/A

	6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	Yes
	6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	Yes
	6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	N/A
	6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	N/A
	6.6.	Were extra or unplanned treatments described?	N/A
	6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	Yes
	6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A
7.	**Were outcomes clearly defined and the measurements valid and reliable?**		Yes
	7.1.	Were primary and secondary endpoints described and relevant to the question?	Yes
	7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes
	7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	Yes
	7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	Yes
	7.5.	Was the measurement of effect at an appropriate level of precision?	Yes
	7.6.	Were other factors accounted for (measured) that could affect outcomes?	???
	7.7.	Were the measurements conducted consistently across groups?	Yes
8.	**Was the statistical analysis appropriate for the study design and type of outcome indicators?**		Yes
	8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
	8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes
	8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
	8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	N/A
	8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	Yes
	8.6.	Was clinical significance as well as statistical significance reported?	Yes
	8.7.	If negative findings, was a power calculation reported to address type 2 error?	N/A
9.	**Are conclusions supported by results with biases and limitations taken into consideration?**		Yes
	9.1.	Is there a discussion of findings?	Yes
	9.2.	Are biases and study limitations identified and discussed?	Yes
10.	**Is bias due to study's funding or sponsorship unlikely?**		Yes
	10.1.	Were sources of funding and investigators' affiliations described?	Yes
	10.2.	Was the study free from apparent conflict of interest?	Yes